Planetary Defense Briefing to Fall PAC 2021

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Washington, DC

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PLANETARY DEFENSE COORDINATION OFFICE

UN Office of Outer Space Affairs
Committee on Peaceful Uses of Outer Space

Overview for NEO Threat Response

United Nations
COPUOS/OOSA

Inform in case of credible threat

Parent Government Delegates

Determine Impact time, location and severity

International Asteroid Warning Network (IAWN)
www.iawn.net

Observers, analysts, modelers…

Organized by NASA

Potential deflection mission plans

Space Missions Planning Advisory Group (SMPAG)
www.smpag.net

Space agencies and offices

Chaired by ESA

Signatories to the International Asteroid Warning Network (IAWN)

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NASA

Currently 35 signatories

https://iawn.net/about/members.shtml

Newest Signatories to IAWN :

Xingming Observatory, China

6ROADS Company, Poland

Squirrel Valley Observatory, United States

Golden Ears Observatory Canada

Astronomical Institute of the Romanian Academy

Brazil	Southern Observatory for Near Earth Asteroids Research, Brazil
Canada	Golden Ears Observtory U55
Canada	Spaceguard Consulting, Canada
China	Chinese National Space Administration, China
China	Xingming Observatory (IAU Code C42/N88/N89)
Colombia	Unversity of Narino, Colombia
Crimea	Mobil Astronomical Robotics Genon Observatory
Croatia	Visnjan Observatory, Croatia
Europe	European Southern Observatory
Europe	European Space Agency, Head NEO Segment, SSA Programme Office
France	Observatoire de la Côte d'Azur, Nice, France
Israel	Israel Space Agency
Italy	Agenzia Spaziale Italiana
Italy	Fondazione GAL Hassin
Italy	G.V. Schiaparelli 204, Italy
Italy	Sormano Observatory, Italy
Korea, Republic of	Korean Astronomy and Space Sciences Institutde, Republic of Korea
Latvia	Baldone Observatory 069, Latvia
Mexico	National Institute of Astrophysics, Optics, and Electronics, Mexico
Poland	6ROADS Company
Romania	Astronomical Institute of the Romanian Academy
Russia	Crimean Astrophysical Observatory, Russia
Russia	Institute of Solar-Terrestrial Physics, Russian Academy of Sciences, Russia
Russia	Keldysh Institute of Applied Mathematics, Russian Academy of Sciences, Russia
Russia	Kourovka Astronomical Observatory, Ural Federal University, Russia
Russia	Russian Academy of Sciences, Institute of Astronomy, Russia
Russia	Special Astrophysical Observatory, Russian Academy of Sciences, Russia
Spain	Insituto de Astrofisica de Canarias
Spain	The Paus B49 Observatory
United Kingdom	Northolt Branch Observatories, England
United Kingdom	Peter Birtwhistle, Great Shefford Observatory, England
United States	National Aeronautics and Space Administration (Pan-STARRS, Catalina Sky Survey, ATLAS, etc)
United States	Patrick Wiggins, Tooele Observatory, Utah, United States
United States	Squrrel Valley Observatory W34
United States	Zwicky Transient Facility, Caltech, United States

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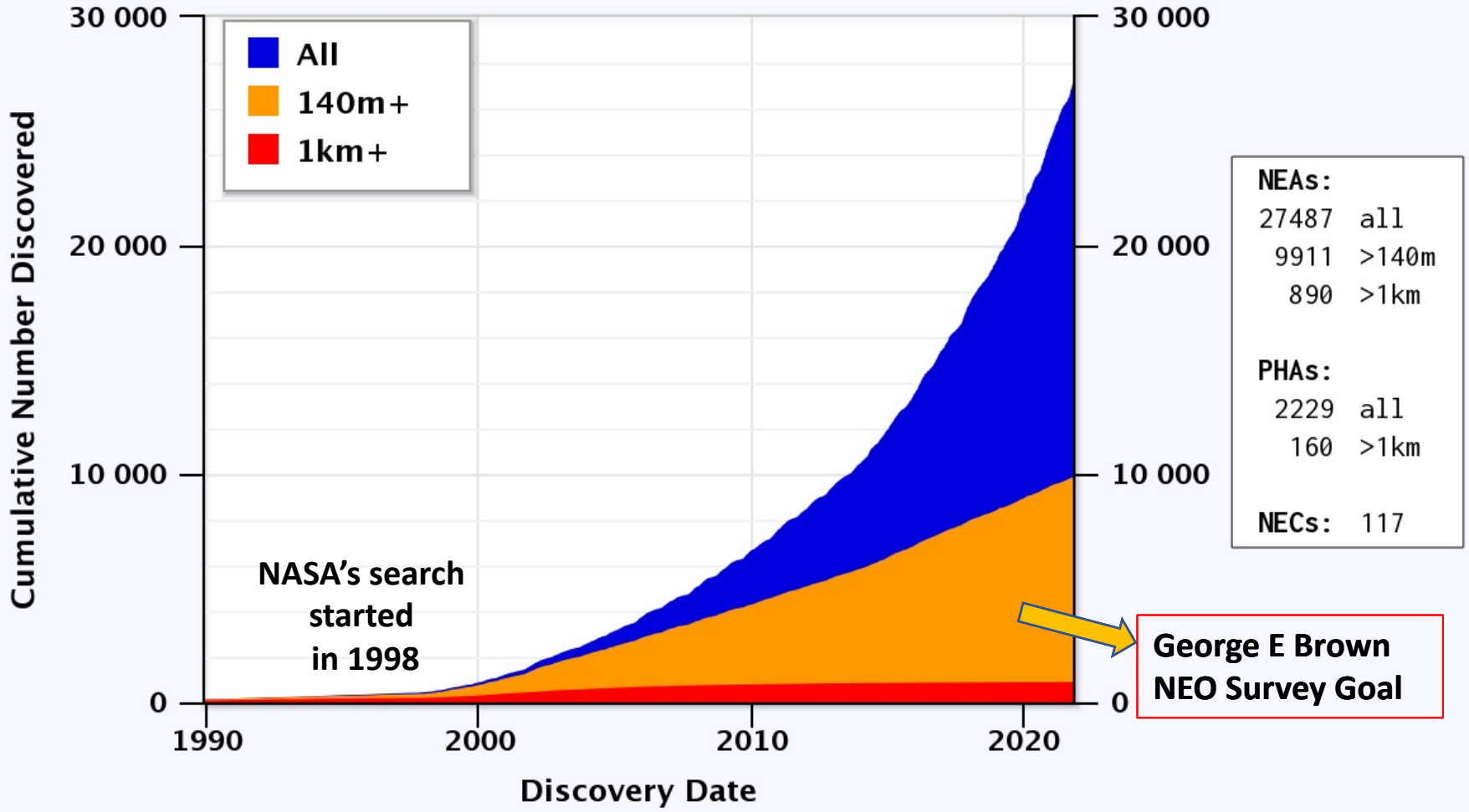
Near-Earth Asteroids Discovered

Most recent discovery: *2021-Nov-13*



https://cneos.jpl.nasa.gov/stats/

Alan Chamberlin (JPL/Caltech)

**Potentially Hazardous Asteroids come within 7.5 million km of Earth orbit*

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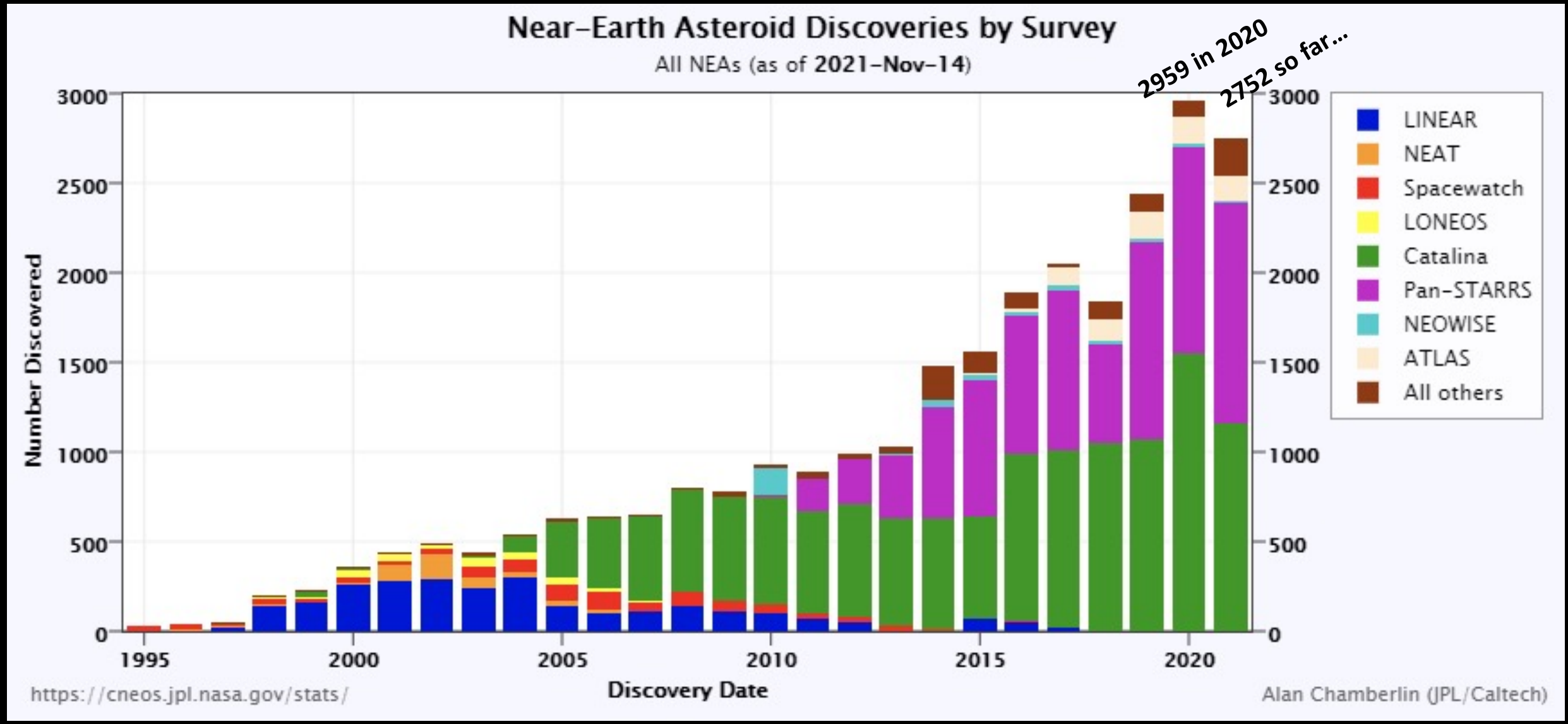
All Near-Earth Asteroids (NEAs)



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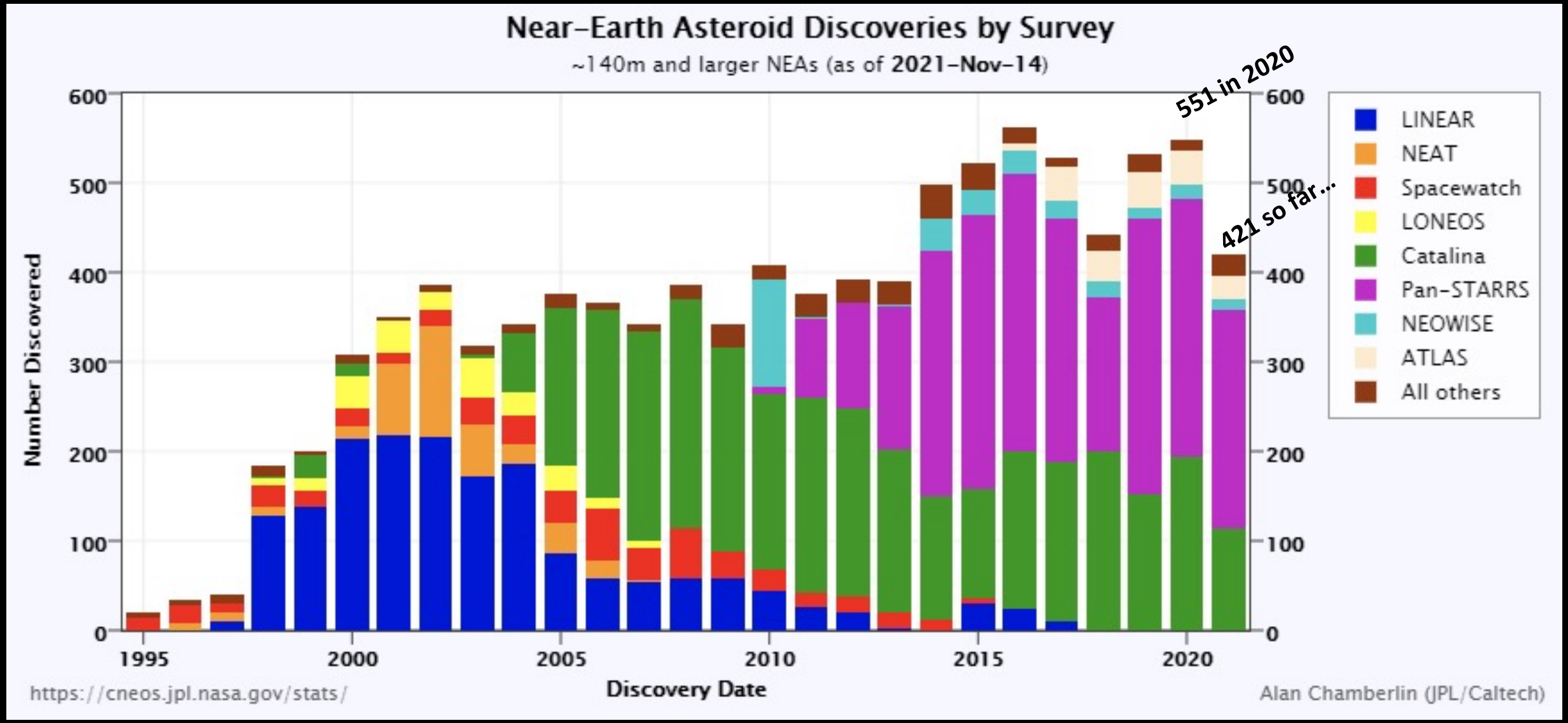
NEAs 140 Meters and Larger



DART

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NASA

APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Double Asteroid Redirection Test (DART) is 1 week to Launch!!

DART is the first full-scale flight demonstration of an asteroid deflection technology: kinetic impact

DART = Double Asteroid Redirection Test

- **There is no known asteroid that poses an actual impact risk to Earth.**
- The impact hazard is from asteroids not yet discovered - ~60% population.
- The test is being conducted to develop a deflection capability, in case one is needed in the future.
- The binary asteroid system Didymos system is not a threat to Earth and provides a natural environment to change the orbit of a smaller asteroid orbiting a larger, rather than an asteroid orbiting the sun. This ensures the test does not accidentally create an impact hazard to Earth.

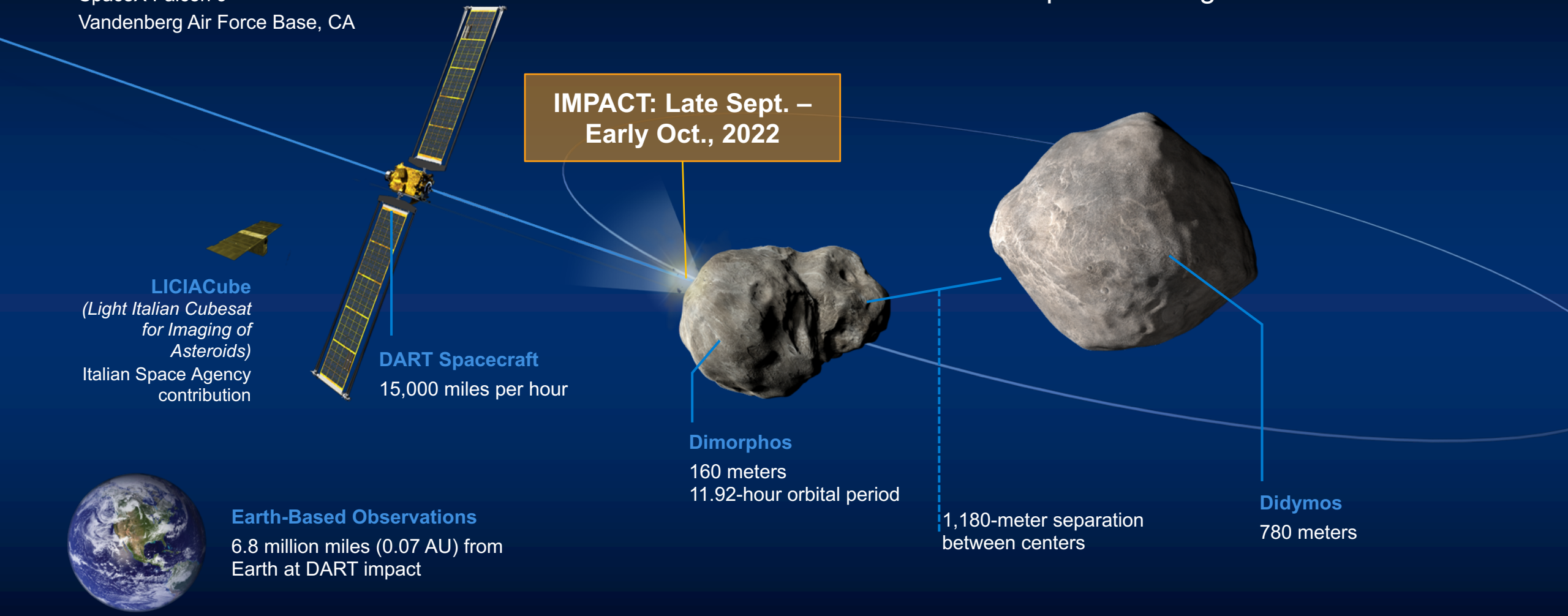
Launch Period

Nov. 24, 2021 – Feb. 15, 2022

SpaceX Falcon 9

Vandenberg Air Force Base, CA

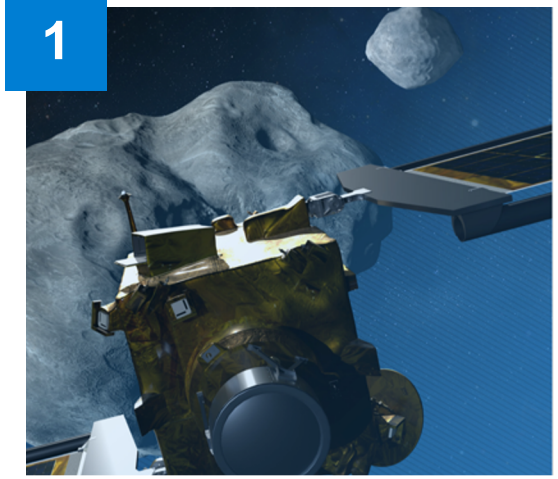
- Target the binary asteroid Didymos system
- Impact Dimorphos and change its orbital period
- Measure the period change from Earth



DART's Level 1 Requirements

Defining the Mission's Planetary Defense Investigation

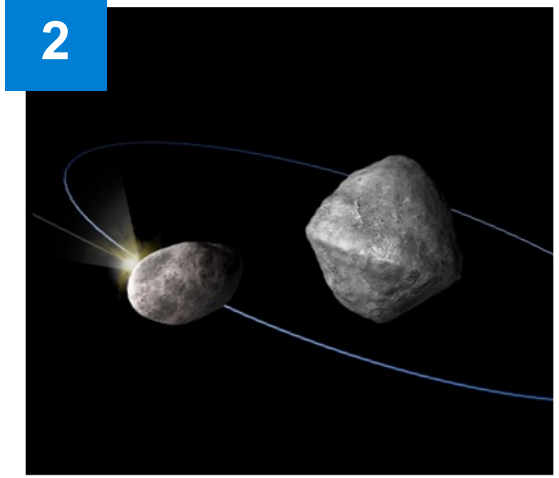
1



Impact Dimorphos

During its Sept/Oct 2022 close approach to Earth

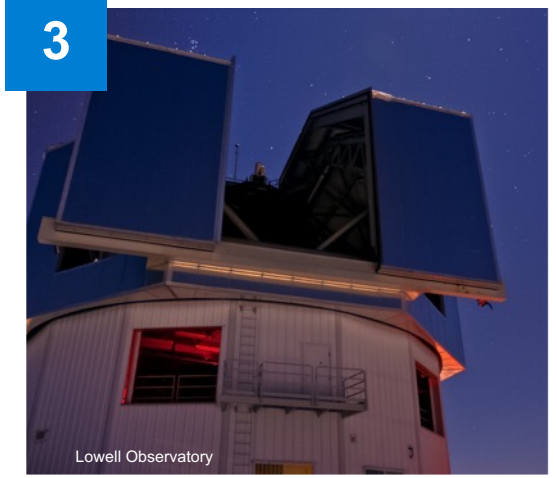
2



Change the binary orbital period

Cause a ≥73-second change in the orbital period of Dimorphos

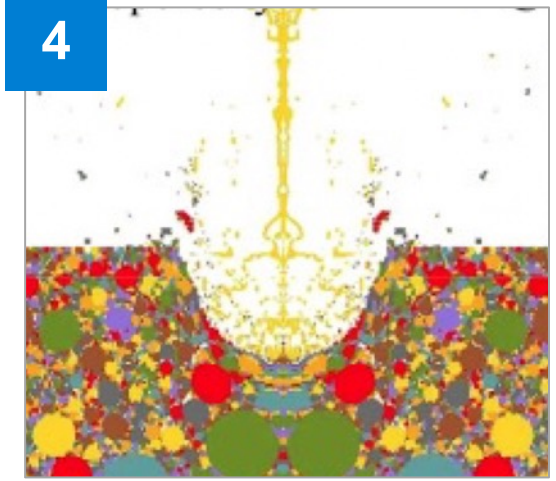
3



Measure the period change

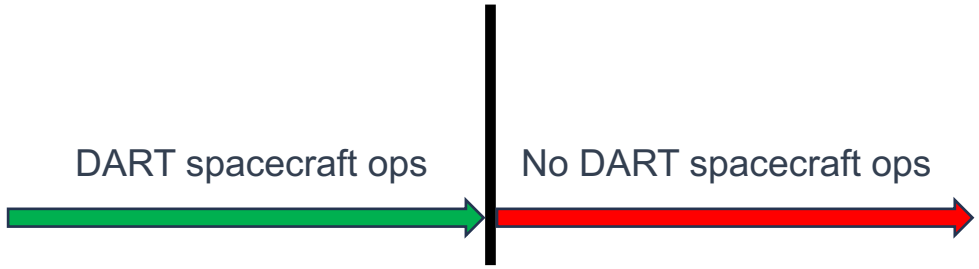
To within 7.3 seconds, from ground-based observations before and after impact

4

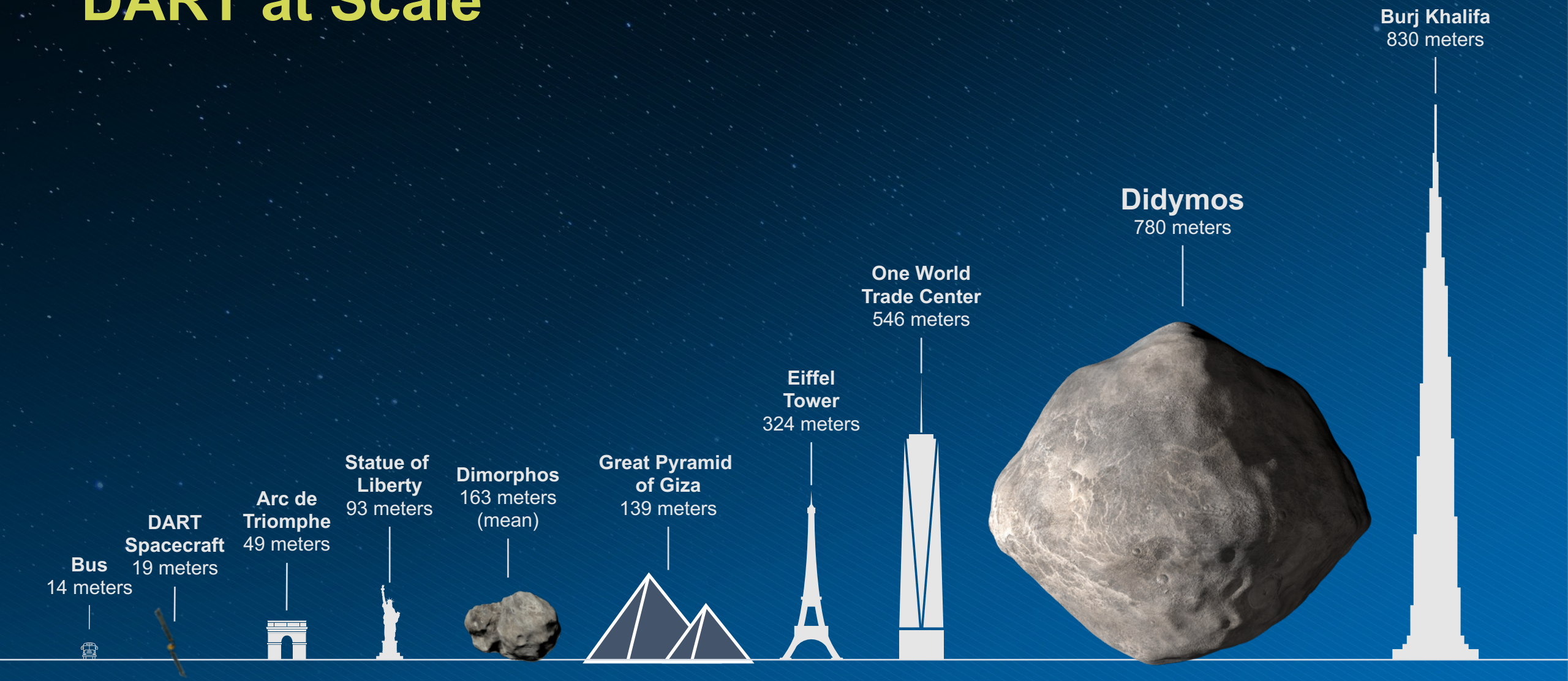


Measure "Beta" and characterize the impact site and dynamics

Beta *= the momentum enhancement factor*



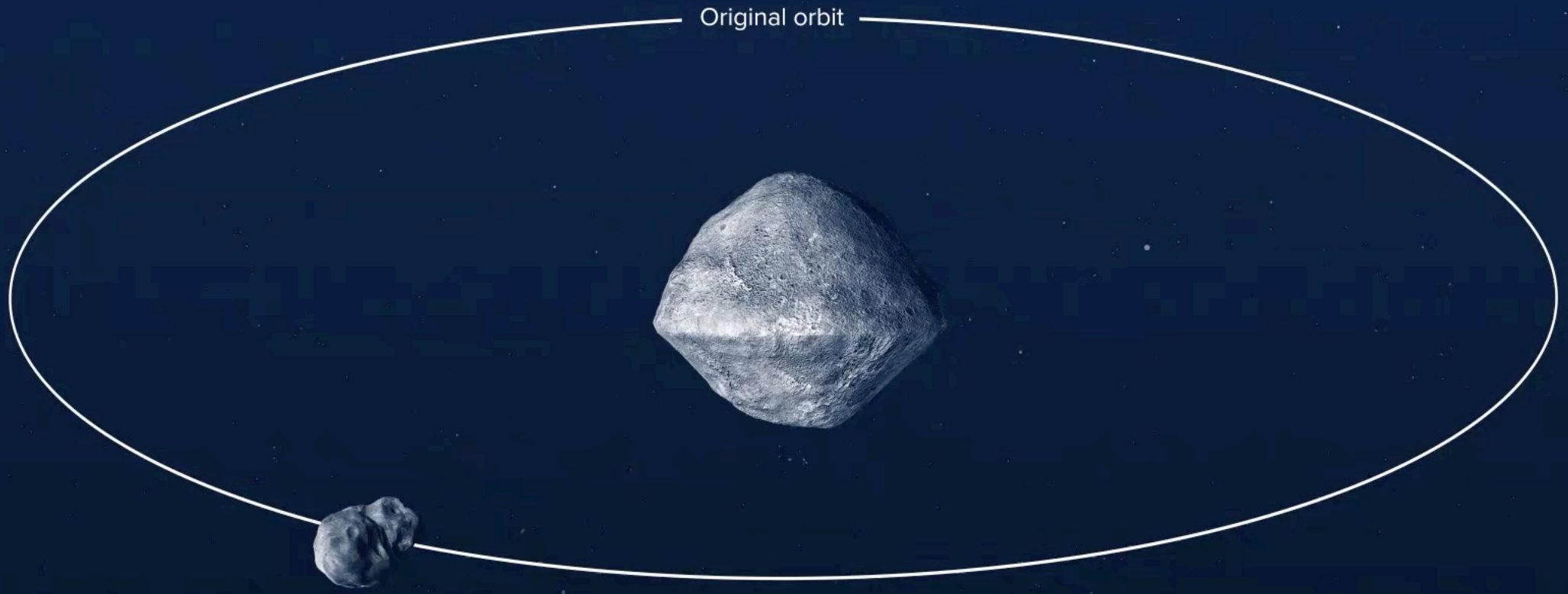
DART at Scale



DART

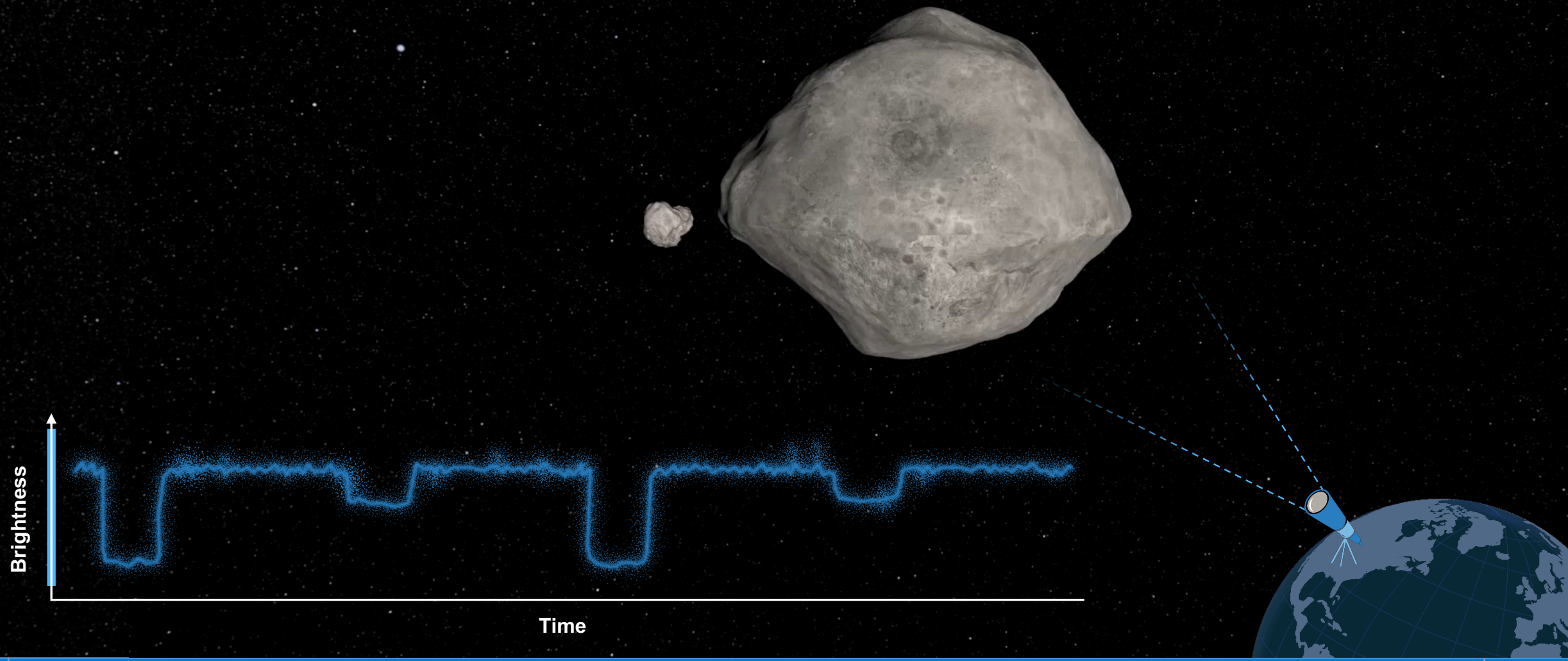
Double Asteroid Redirection Test

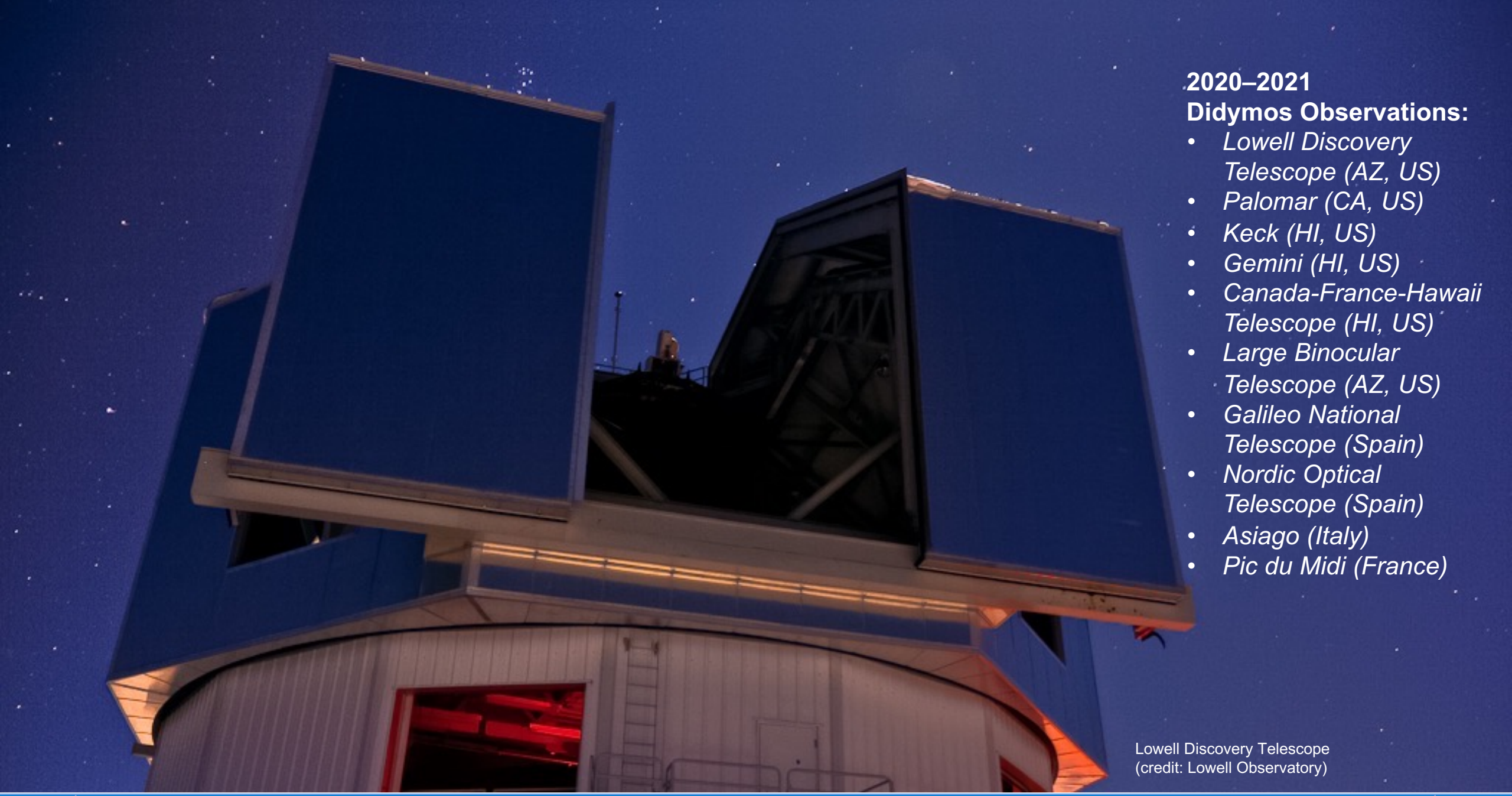
It allows a deflection demonstration on an asteroid of the relevant size by changing its orbital period by **~1%** about the larger asteroid.



Earth-based observations

Measuring result of the impact from Earth: new orbit for Dimorphos





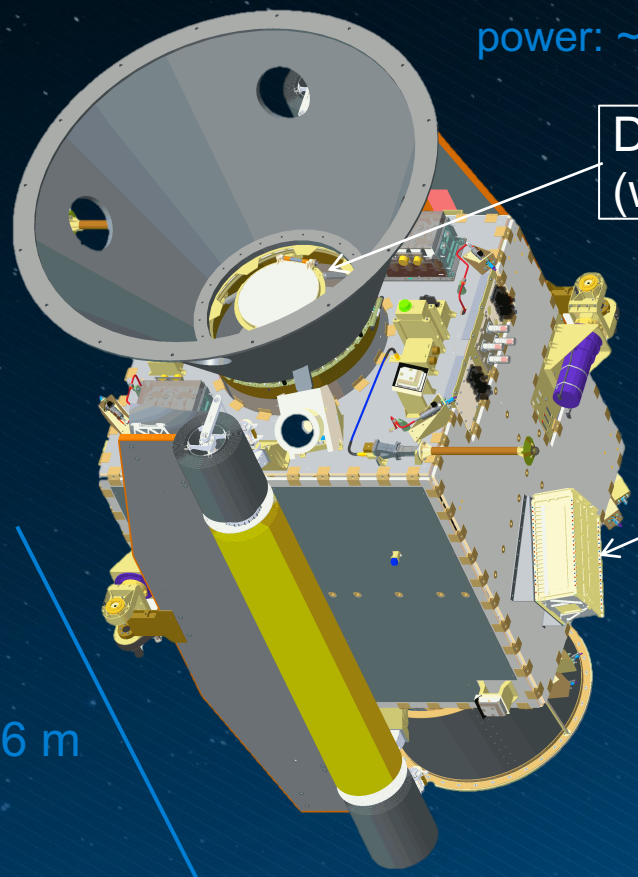
2020–2021
Didymos Observations:

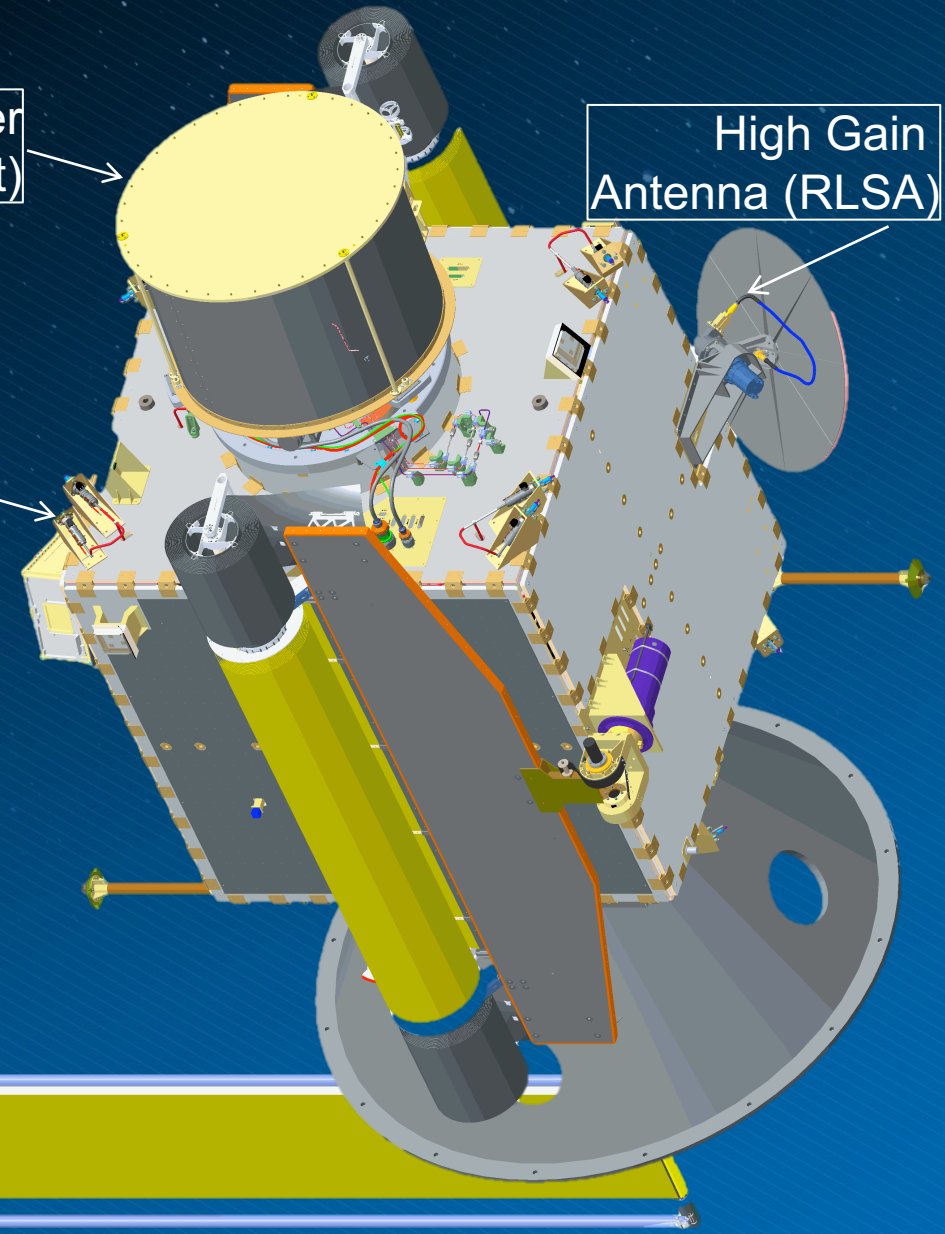
- *Lowell Discovery Telescope (AZ, US)*
- *Palomar (CA, US)*
- *Keck (HI, US)*
- *Gemini (HI, US)*
- *Canada-France-Hawaii Telescope (HI, US)*
- *Large Binocular Telescope (AZ, US)*
- *Galileo National Telescope (Spain)*
- *Nordic Optical Telescope (Spain)*
- *Asiago (Italy)*
- *Pic du Midi (France)*

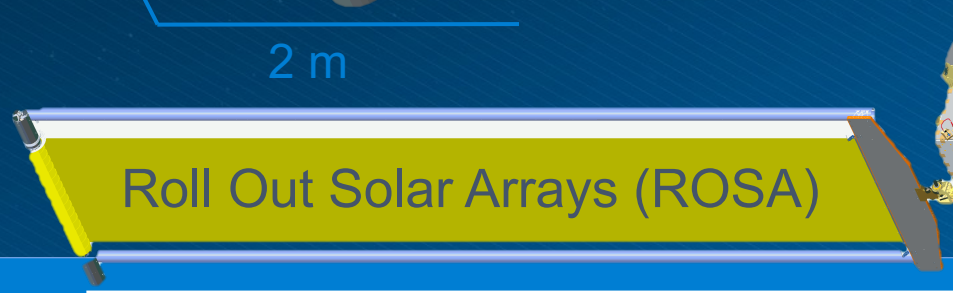
Lowell Discovery Telescope
(credit: Lowell Observatory)

DART Spacecraft

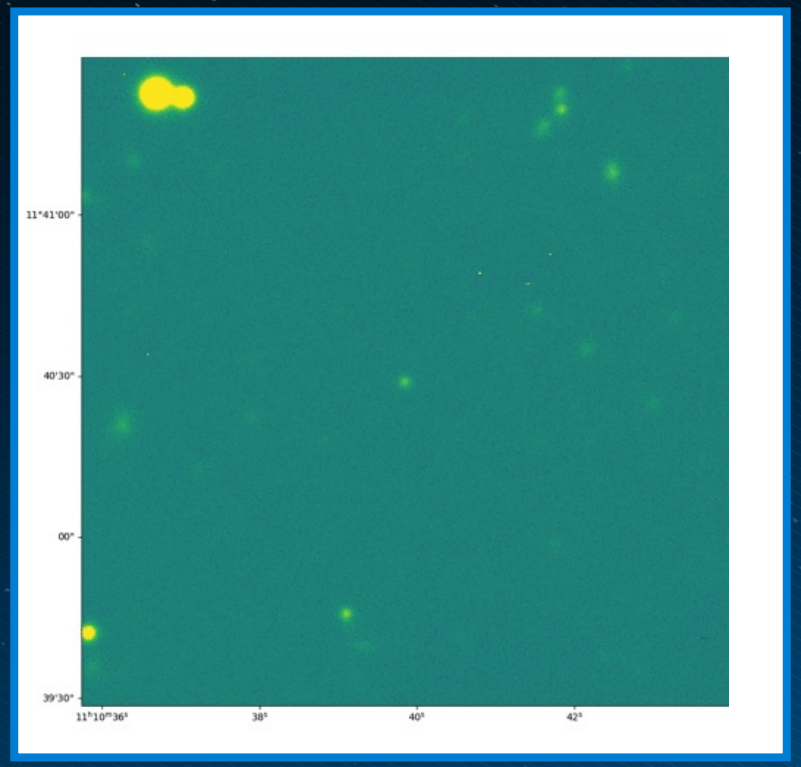
mass: NLT 670 kg
power: ~5000 W



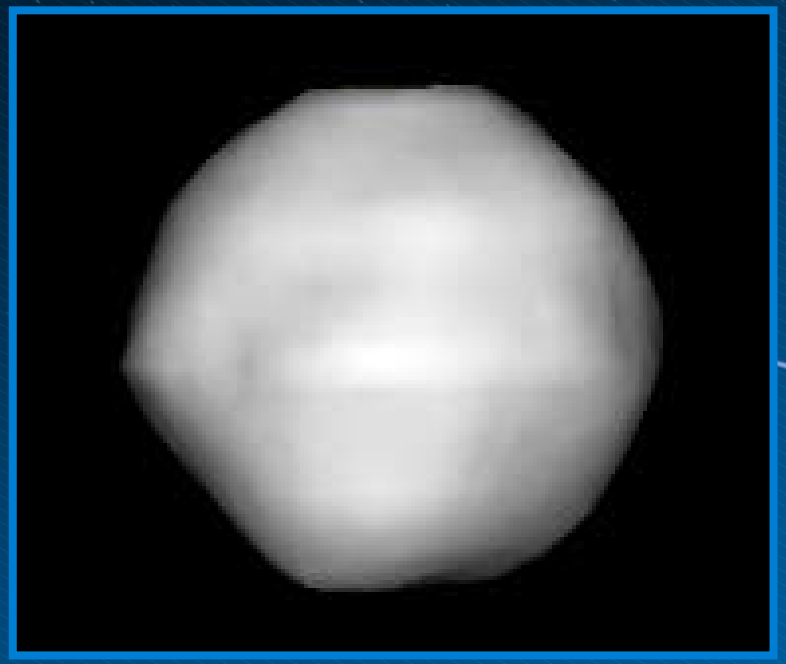


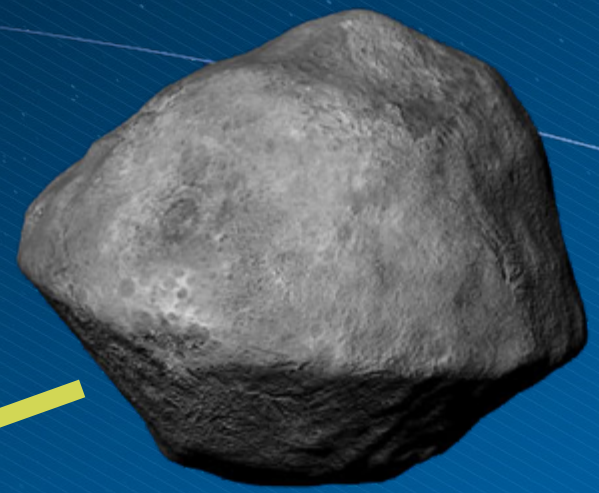


Know little about the object we are going to hit



Images centered on Didymos, moving through star fields
Taken from VLT in Chile, March/April 2019

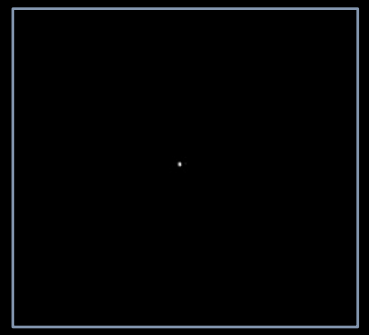




Radar shape model

Preliminary shape model of the Didymos primary asteroid from combined radar and light curve data, diameter ~780 m.

And won’t know much more in time to hit it!



24,000 kilometers
Didymos – 6.5 pixel
Dimorphos – 1.4 pixel
Target becomes observable

60 minutes

1600 kilometers
Didymos – 99 pixel
Dimorphos – 21 pixel
Final divert maneuver corrections

4 minutes

800 kilometers
Didymos – 197 pixel
Dimorphos – 41 pixel
Divert maneuvers complete, drift to impact

2 minutes

130 kilometers
Didymos – N/A
Dimorphos – ~300 pixel
Pixel-scale requirements met

20 seconds

30 days | 10 days | 8 hours | 4 hours | **60 minutes** | **4 minutes** | **2 minutes** | **20 seconds**

Schedule to Launch

Testing complete
Load xenon
Closeouts

Pack and ship

Arrive at Astrotech processing facility

Electrical tests

Transport to Space X processing facility

Load hydrazine
Charge battery

Mate to adapter
Encapsulate in launch vehicle fairing

JHU/ APL

VSFB

now

9/29

10/3

10/7

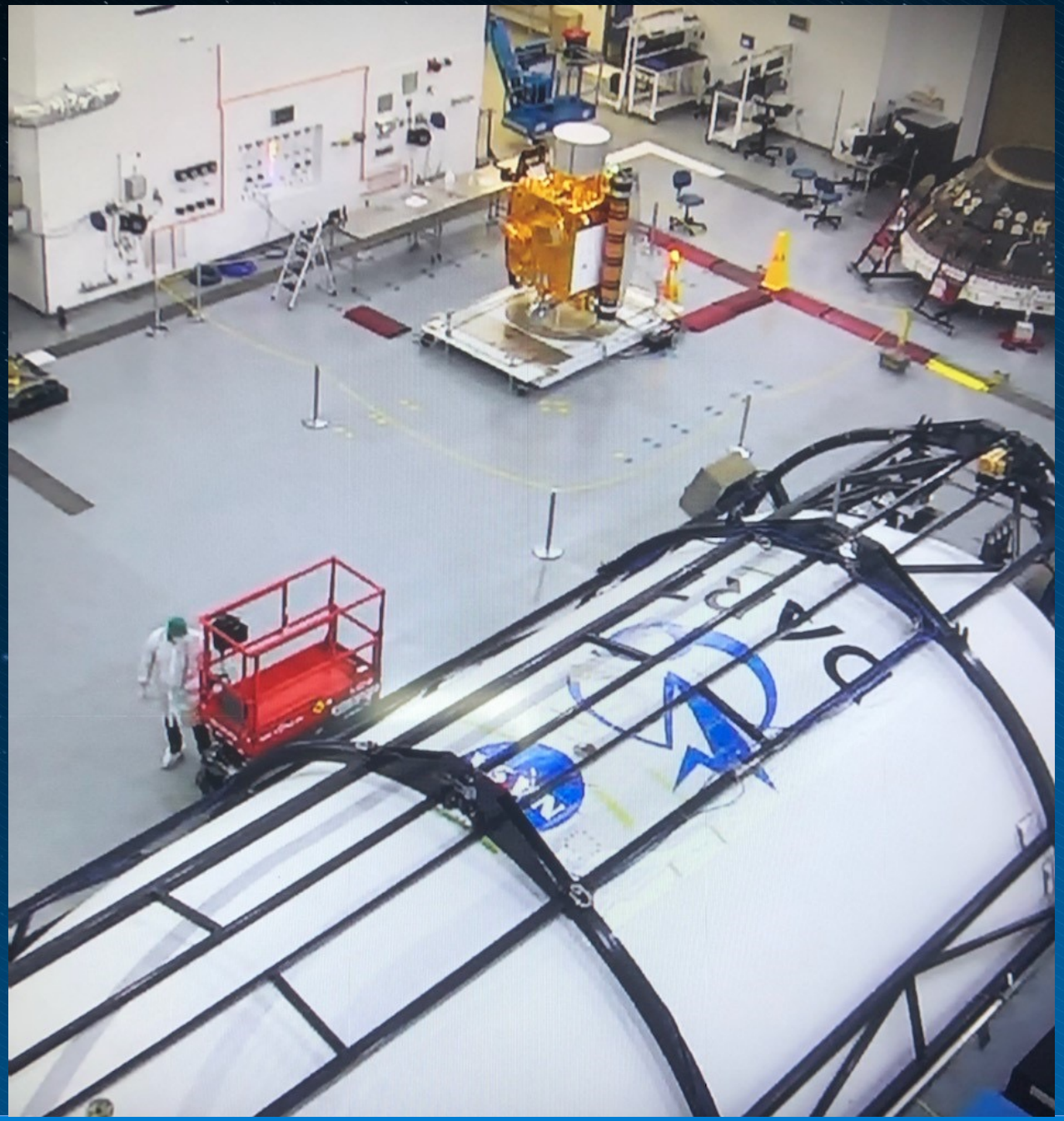
10/23

10/27

11/12

11/23
Local time
PST

DART in highbay at Space X processing facility



Link to Video

Video Overview, DART, NASA's First Planetary Defense Mission

https://youtu.be/hbL07cZUEMU

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nasa.gov/planetarydefense